THE "SPRINGING" OF TINS OF PRESERVED FRUIT.

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It occasionally happens in the canning of fruit that some of the tins, after a time, begin to swell. Normally, the top and bottom of the container are slightly concave, indicating a partial vacuum within If, however, one or both is convex, the tin is abnormal and is alluded to as a "springer." Such cans are rejected, and, as there may be many sprung tins, the loss may be considerable to the canner. The cause is generally ascribed to leaking containers, but as some fruits are more prone to produce "springers" than others, it appeared that much might be gained from a study of the phenomenon. It is certainly curious that, while pears and some varieties of plums with tight stones are frequently affected in this way, peaches and other stone-fruits are but rarely so, even when they are processed or manufactured in precisely the same way. Our attention was called to the matter, and an examination was made of some of the affected tins.

But before dealing with the results of this examination, it may be well to briefly describe the method of processing the fruit. The pears, generally the Bartlett variety, are picked, pared, cut in two, cored, in some cases sliced, and washed in running water. They are then put into empty containers, and placed on a travelling belt which carries them past a tap from which boiling syrup is run in up to within a quarter or half-an-inch of the top. They pass on to a machine which automatically fits on the lids and turns the edges. The cold pears reduce the temperature of the syrup, which is generally at 160°F., when the lid is fixed and the container made tight. The tins are put into baskets and passed through a boiler. The passage occupies 24 minutes, and the tins are in the boiling water zone for 16 minutes. On

emerging from the boiler, the ends are bulged, but they become concave as the tins cool, while stacked on the floor near the boiler. When cold, they are taken to the store, and built up in tiers so that any springers may be detected. After a time, they are labelled and despatched.

The springers appear to be of two kinds. One contains syrup in an actively fermenting condition; the other is quite still, but the syrup has a sharp, slightly acid taste noticeable only to the expert taster, and the fruit is apparently quite fit for human consumption. The fact that one or both ends of the container are bulged is, however, sufficient to cause the condemnation of the tin.

The time during which the fruit is cooked seems to be sufficient to thoroughly pasteurise the contents of the tins, but to gain some definite information upon the matter, two tests were made in the laboratory with fresh pears. These were peeled, halved, and cored. The bulb of a thermometer was inserted in the body of one of the halves and the tin was filled up with boiling syrup, and put into boiling water. The temperatures of the pear and of the syrup were read off at intervals.

	Temperature in °C. of the	
	pear	syrup
At start	18°	81°
2 minutes	27°	84°
5 minutes	42·5°	87°
10 minutes	65·5°	90·5°
15 minutes	78°	92°
20 minutes	85°	94·5°
24 minutes	89°	95°
Container taken out and placed on bench		
28 minutes	90°	87·5°
30 minutes	90°	85·5°
35 minutes	88°	78·5°
40 minutes	85°	74°

The conditions were not quite the same as in processing under factory-conditions, inasmuch as there was no lid on the container, and it was not completely submerged in the boiling water.

For this reason, these temperatures are lower than would occur in practice, but even as, in the experiment, the pears and the syrup were over 70°C. for at least 30 minutes, and over 85° for 20 minutes, the exposure was quite sufficient to pasteurise the contents

One point about the experiment was, that the tin was put into the boiling water immediately the syrup was added; whereas in practice, a certain time must elapse before the tin is capped, put into a basket and pushed into the boiler, where it is some four minutes before the zone of boiling water is reached. It was considered that an interval of ten minutes would completely cover this interval, and, accordingly, in another laboratory-test, the container was allowed to stand for ten minutes after receiving the boiling syrup, and before it was put into the boiling water.

	Temperature in °C. of the	
	pear	syrup
At start	45°	47°
5 minutes	50°	67·5°
10 minutes	67°	80°
15 minutes	76°	85°
20 minutes	80·5°	88°
24 minutes	83°	89·5°
Container taken out and placed on bench		
28 minutes	84°	87·5°
30 minutes	83·5°	86°
40 minutes	79°	78°

Even with the ten-minute interval before placing the tin in the boiling water, the fruit and the syrup were well over 70° for at least 25 minutes, and this should be enough to destroy all vegetating yeasts and bacteria.

A number of faulty tins, ten in all, were received in October, 1916. They consisted of pears, greengages, and plums. They were examined bacteriologically, and no growths were obtained from the contents of seven. A tin of pears contained a small active yeast, *Saccharomyces Zopfii*, which has been shown to be responsible for the "puffing" of tins of golden syrup in America.

It actively fermented fruit-syrup, and was undoubtedly the cause of the springing of this particular tin. Another tin of pears contained a mixture of inactive yeasts and moulds. As they did not ferment fruit-syrup, it was clear that the cause of the trouble had disappeared. A tin of greengages contained inactive bacteria and moulds, and, as in the previous case, the agent which had caused the fermentation had died or had been killed. Several of the containers showed clear evidence of having leaked at some time.

A second lot of six faulty tins of pears was obtained in June, 1917, and the notes upon these are as follows.

No.1. The container had a faulty lid, the tinplate was spongy, and foaming syrup was oozing out of a central pin-hole. The syrup was actively fermenting and contained yeasts.

No.2. The container had a small quantity of syrup, the bulk having apparently leaked out. The syrup contained yeasts and, when set aside under aseptic conditions, it fermented vigorously.

No.3. The contents appeared to be normal, but the syrup contained bacteria and yeasts.

No.4. The fruit appeared normal, but the syrup was thin, and contained bacteria and yeasts.

Nos.5 and 6. The contents were normal, and the syrup contained bacteria only.

All the containers, with the exception of No.6, showed signs of having leaked at some time. No.6 was the only one that appeared to be intact.

The bacteria in the tins were the same. On dextrose agar, they grew as short, irregular rods, and as chains, especially in the condensed water. They were Gram-positive, and, as they had no action upon any sugar, they could not have been responsible for the springing of the retainers.

The yeasts were all of the culture-type, that is, they were varieties of *Saccharomyces cerevisiæ*. This type is associated with the manufacture of beer, and one would not expect to find it in a factory where there is so much fruit utilised. In a factory such as a fruit-cannery, wild yeasts and torulæ should be present in abundance, and it certainly was extraordinary to find only

culture- or beer-yeasts in the preserved pears. It was subsequently discovered that, adjoining the cannery, there is a factory, where a large amount of ginger-beer is produced. It is safe to conclude that the yeasts came from this source.

In October, 1917, a third lot of six tins of pears was examined, and, with one exception, all of them showed signs of leakage. The contents were sterile, and, from the presence of soldered vent-holes on two of the containers, it was concluded that the lot had been reprocessed, that is to say, they had been put through the boiler after evidence of springing had been detected. One of the tins contained a strongly foaming, sterile syrup, and as this was oozing from one of the ends, it was evident that the re-processing had been of recent date.

We had an opportunity of inspecting the processing of pears in February, 1918, and, from our observations, we concluded that the root of the trouble lay with the closing of the containers. The margin of the lid is painted with a mixture containing flour or starch, and when the closing machine overlaps the edges of lid and container-top, the mixture fills up the spaces between the interlocked edges. The joint appears to be tight, and doubtless the starchy mixture makes a good lute. But the pressure exerted by the air contained in the tin (it constitutes from one-twelfth to one twenty-fourth of the contents) must be considerable during the passage of the container through the boiler. The luting mixture is supposed to form a jelly in contact with the hot water, on the one side, and the hot syrup on the other, and it is quite reasonable to suppose that the jelly may be forced out of the joint by the pressure of the contents. The tins appear to be sound immediately after processing; it is when they are stacked in the store-room, that they show signs of leakage. In the case of pears, about every second tin leaks more or less; with plums, about every tenth tin is faulty; and, with peaches and apricots, the leaks are few in number. As the processing is the same in all cases, one is driven to the conclusion that the juice of pears and, in less degree, that of plums, has a solvent action upon the luting jelly, and that another mixture should be employed.

The experimental evidence shows that the duration and temperature of the processing are sufficient to absolutely free the contents from active yeasts. Their entry into the containers is most likely to occur while the tins are cooling down or shortly after. It is reasonable to suppose that the original air of the tin has been partly or entirely expelled during processing, and the vacuum created during cooling draws in the air of the factory with its suspended yeasts and other organisms. It is entirely a matter of chance as to the number of organisms and the activity of the organisms that may be in the indrawn air. There may be none, or they may be inactive, and the tin will not leak. There may be one or more, and, if these are active gas-producers, the tin will "spring." It is quite possible that some of the tins might be so imperfectly closed that they would leak under any circumstances, but the scarcity of leaks and springers among the tins of stone-fruits shows that this is of very rare occurrence.

The behaviour of the pears and plums, as compared with apricots and peaches, points to the use of a more insoluble luting material, and, failing this method of overcoming the trouble, there is the alternative and probably better plan of allowing the tins to cool after processing in a current of filtered, sterile air, and, when cold, painting the joints with a lacquer-varnish. Thus the entry of yeasts into the tins would be prevented during the cooling, and the varnish would make them germ-tight and germ-proof.